

Abstract of the Disclosure

A method of this invention includes annealing at least one region of a substrate with a short pulse of particles. The particles can be electrons, protons, alpha particles, other atomic or molecular ions or neutral atoms and molecules. The substrate can be composed of a semiconductor material, for example. The particles can include dopant atoms such as p-type dopant atoms such as boron (B), aluminum (Al), gallium (Ga), or indium (In), and n-type dopant atomic species including arsenic (As), phosphorus (P), or antimony (Sb). The particles can also include silicon (Si) or germanium (Ge) atoms or ionized gas atoms including those of hydrogen (He), oxygen (O), nitrogen (N), neon (Ne), argon (Ar), or krypton (Kr). The particles can be used to anneal dopant atoms previously implanted into the substrate.

Alternatively, the particle species can be chosen to include the desired implant dopant, the energy of the particle may be chosen to achieve the desired implant depth, and the energy, dose and pulse duration may be chosen to anneal the implanted region during the pulse. This embodiment of the method performs implantation and activation in a single step. If no change in the electrical state of the substrate is required, the particles can include silicon (Si), and germanium (Ge) atoms.